

A NEW SPECIES OF NORTH AMERICAN *PROTOCALLIPHORA* HOUGH  
(DIPTERA: CALLIPHORIDAE) FROM BIRD NESTS

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*Abstract.*—Adult and puparial characters of the bird nest blow fly, *Protocalliphora sialia* Shannon and Dobrosky (Diptera: Calliphoridae) are evaluated as to whether the eastern and western North American populations should be considered separate species. Based on an analysis of adult and puparial ratios and a variety of morphological features, the western North American populations are described as *P. occidentalis*, new species.

*Key Words:* bird, nest, blow fly, *Protocalliphora, sialia*, Diptera, Calliphoridae, North America, new species

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Larvae of species of *Protocalliphora* Hough (bird blow flies) are obligate blood-sucking parasites of altricial nestling birds. Twenty-eight species of *Protocalliphora* have been described from North America, including two which are Holarctic, while 13 species have been described from the Palearctic Region. Sabrosky et al. (1989) re-described 11 North American species and described 15 new species. Whitworth (2002) recently described two new species of *Protocalliphora* in North America.

*Protocalliphora sialia* Shannon and Dobrosky infests a broad range of hosts and is one of the most commonly collected bird blow flies in North America. It is found frequently in the cavity nests of bluebirds, tree swallows, and European starlings, as well as occasionally in the open nests of American robins, common ravens, and kingbirds. Bennett and Whitworth (1992) found *P. sialia* in 31% of 667 infested nests of 15 bird species in eastern North America and in 7.3% of 964 infested nests of 18 bird species nests in the West.

*Protocalliphora sialia* is one of several similar species where both sexes have the

same color abdomens and white calypters, and males have digitate surstyli. This group includes *P. shannoni* Sabrosky et al., *P. hirundo* Shannon and Dobrosky, *P. bennetti* Whitworth, and *P. rugosa* Whitworth. A key to assist distinguishing these species was provided in Whitworth (2002).

Male *P. sialia* can be distinguished from similar species by their broad frons, with a frons to head ratio averaging 0.08–0.10, and a polished triangular preocellar area. *Protocalliphora sialia* puparia have a long prothoracic fringe with an average diameter of 500–600 $\mu$  (compared to 350–400 $\mu$  in most species), dorsal cuticle with moderate to pronounced ridges, and long hyperstigmatal spines, averaging 40–50 $\mu$ .

Sabrosky et al. (1989) discussed the possibility that *P. sialia* was actually composed of two separate species. A comparison of adult male and female proportions revealed consistent, but overlapping differences between specimens from eastern and western North America divided roughly by the Great Plains. The most distinctive difference between adults is a polished preocellar area in eastern females, while western fe-

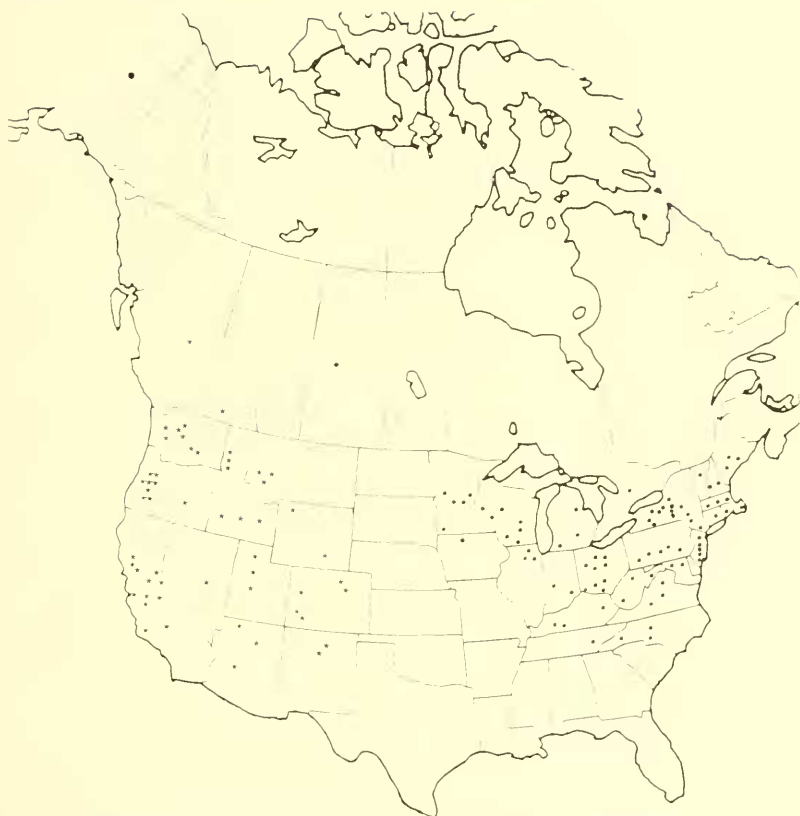


Fig. 1. Distribution of *Protocalliphora sialia* (●) and *P. occidentalis* (★) in North America.

males have a dull, microtomentose preocular area. Only the eastern form of *P. sialia* puparia had been studied at that time and ultimately *P. sialia* was left as one species, pending future research. The purpose of this study is to determine the status of this diverse, widespread species.

#### METHODS AND MATERIALS

*Protocalliphora* are rarely found in nature, except in bird nests. Most of the nests for the current study have been collected

since 1992, via Internet contacts with birders who collected them from bird nest boxes after nestlings fledged. Common bird names are from the "Checklist of North American Birds", 7th edition, American Ornithologists Union (2000). Most material from Utah was collected from 1969–1972. Methods used to sort adults and puparia from nests and to identify *Protocalliphora* species were detailed in Whitworth (2002). Taxonomic terms were defined and an explanation of how to determine ratios in

Table 1. Mean ratios and ranges comparing western, midwestern, and eastern adults of *Protocalliphora sialia* to data from Sabrosky et al. (1989).

|  | Adult Male       |                   |                   |
|--|------------------|-------------------|-------------------|
|  | West             | Sabrosky* West    | Midwest           |
| <i>Frons</i> Head                      | 0.08 (0.07–0.09) | 0.08 (0.07–0.09)  | 0.098 (0.09–0.11) |
| <i>Frons</i> Ocellar Span              | 1.18 (0.8–1.5)   | 1.10 (1–1.25)     | 1.27 (1.18–1.5)   |
| <i>Parafacial</i> <i>Frons</i>         | 1.5 (1.25–2)     | 1.71 (1.5–1.87)   | 1.44 (1.16–1.75)  |
| <i>Parafacial</i> Ocellar Span         | 1.75 (1.5–2.33)  | 1.88 (1.62–20.07) | 1.83 (1.5–2.11)   |
| <i>Parafacial</i> Vibrissal Interval   | 0.92 (0.75–1.18) | 1.00 (0.84–1.18)  | 1.02 (.79–1.13)   |
| <i>Cheek</i> Eye                       | 0.42 (0.33–0.49) | 0.40 (0.38–0.44)  | 0.43 (0.37–0.49)  |
| <i>Frons</i> 3rd Antennal Segment      | 1.23 (.89–1.5)   |                   | 1.23 (1.09–1.5)   |
| <i>Parafacial</i> 3rd Antennal Segment | 1.8 (1.5–2.13)   |                   | 1.78 (1.36–2)     |

\* Data from Sabrosky et al., 1989.

adults and puparia were discussed in Sabrosky et al. (1989). See Whitworth (2002) for further discussion of measuring prothoracic fringe and cuticular spines.

A preliminary comparison of puparia revealed that specimens from the northern midwest (Minnesota and Wisconsin) have some characters intermediate between the eastern and western forms. Therefore, an initial analysis of adult and puparial characters was conducted on three groups: Eastern, western, and midwestern. Twenty-five adults of each sex were measured from all three areas and those measurements are compared in Table 1, along with data from Sabrosky et al. (1989). Twenty-five puparia from each area were also measured and are compared in Table 2.

## RESULTS

A total of 3,849 nests of 76 bird species were collected from 45 states in the contiguous U.S., Alaska and Canada. Of these nests, 39% (1,501) from 49 bird species were infested with 17 species of *Protocalliphora*. Over half of the infested nests (992) from 22 bird species were infested with "*P. sialia*." Nests with this species were collected from 33 states in the contiguous U.S., Alaska, and Canada.

Measurements of adult males, females, and puparia suggest a close relationship between eastern and midwestern *P. sialia*, with western *P. sialia* often significantly

different (Tables 1, 2). Because the midwestern and eastern forms are so similar, the two are combined in further discussion under the eastern form. The eastern form extends northwest from Georgia (recorded by Sabrosky et al. 1989) through Minnesota and Canada to Alaska, while the western form is found from Arizona and New Mexico to Prince George, British Columbia (Fig. 1). Sabrosky et al. (1989) recorded 3 male *P. sialia* from south central Mexico and, although we have not seen these specimens, it seems likely they are the western form, which extends south from New Mexico and Arizona.

Although the stigmatal regions of puparia often appeared quite different (Fig. 2), differences in measurements of the eastern and western forms were relatively small and ranges overlapped (Table 1, 2). Some midwestern puparia exhibited intermediate characters between the two forms, suggesting possible interbreeding, though the midwestern form was closer to the eastern form, indicating that two species were involved. This conclusion was further supported by the results of molecular analysis which revealed two well-separated groups, one composed of the eastern and midwestern forms and the other of western forms (E. Baudry, personal communication). Baudry and I are conducting a study of the taxonomic relationship between species of

Table 1. Extended.

| Adult Male       |                  | Adult Female     |                  |
|------------------|------------------|------------------|------------------|
| East             | Sabrosky* East   | West             | Sabrosky* West   |
| 0.10 (0.09–0.12) | 0.09 (0.08–0.11) | 0.28 (0.27–0.31) | 0.27 (0.25–0.30) |
| 1.4 (1.2–1.75)   | 1.37 (1.13–1.67) | 3.48 (3.08–4.10) | 3.58 (3.06–4.00) |
| 1.35 (1.2–1.67)  | 1.43 (1.20–1.62) | 0.49 (0.43–0.56) | 0.53 (0.48–0.60) |
| 1.88 (1.46–2.22) | 1.96 (1.69–2.18) | 1.68 (1.45–2.11) | 1.91 (1.73–2.29) |
| 1.06 (.94–1.25)  | 1.04 (0.93–1.13) | 1.06 (0.68–1.27) | 1.03 (0.90–1.20) |
| 0.44 (0.41–0.47) | 0.42 (0.38–0.45) | 0.48 (0.40–0.54) | 0.43 (0.41–0.47) |
| 1.26 (1–1.46)    |                  | 3.93 (3.4–4.5)   |                  |
| 1.71 (1.33–2)    |                  | 1.94 (1.67–2.25) |                  |

*Protocalliphora*, based on molecular analysis, and plan a future publication.

*Protocalliphora sialia* was originally described as a new variety by Shannon and Dobrosky (1924), and no holotype was designated. Sabrosky et al. (1989) selected a lectotype and paralectotypes from Pennsylvania, so the eastern and midwestern populations are *P. sialia*, while the western populations are hereby named, *P. occidentalis*. I collected specimens of both species unless indicated otherwise. Most were taken from bird nests donated by birders who collected nests from nest boxes.

*Protocalliphora (P.) sialia*  
Shannon and Dobrosky  
(Figs. 2a, b, 3a,c)

*Protocalliphora splendida* var. *sialia* Shannon and Dobrosky 1924: 251.

*Apaulina sialia*: Hall 1948.

*Protocalliphora sialia* (eastern and western form): Sabrosky et al. 1989.

Diagnosis.—See Tables 1 and 2 for comparisons of ratios and measurements for adults and puparia. Male frons to head ratio averages 0.10 (0.09–0.12) vs. 0.08 (0.07–0.09) in *P. occidentalis*. Male polished preocellar area usually larger in *P. sialia* (Fig. 3a) vs. smaller in *P. occidentalis* (Fig. 3b). Female frons to head ratio relationship is opposite of the males. For *P. sialia* it is smaller averaging 0.25 (0.22–0.28) vs. 0.28 (0.27–0.31); preocellar area usually polished (Fig. 3c) vs. dull colored and micro-

tomentose (Fig. 3d). Stigmatal region of puparia with pronounced folds (Fig. 2a) vs. folds faint to absent (Fig. 2c); ventral band ratio averages 0.83 (0.71–0.89) vs. 0.72 (0.57–0.85) (Table 2).

Material examined.—CANADA, ONTARIO: 2 nests Algonquin Park, Summer 1955, G.F. Bennett collector; 6 puparia, barn swallow nest #504; 6 puparia, nest #445, no host given. SASKATCHEWAN: 1 puparium, Saskatoon, kestrel nest #2548, Summer 1995.

UNITED STATES: ALASKA: Fairbanks, Creamer's Field, 2 tree swallow nests, July 1994, D.D. Roby collector; 12 puparia mixed with 27 puparia of *P. braueri* (Hendel) and 34 puparia of *P. bennetti* Whitworth, nest #41, 3 puparia mixed with 4 puparia of *P. bennetti*, and 10 puparia of *P. braueri*, nest #42. INDIANA: 55 adults, 60 puparia, Union Co., Brookville, eastern bluebird nest #4754, 5/24/01; 19 puparia, Terre Haute, eastern bluebird nest #3770, 6/29/00. KENTUCKY: 15 puparia mixed with 10 puparia of *P. deceptor* Sabrosky, Bennett, and Whitworth, Ashland, warbler species nest #3377, 6/10/00. MARYLAND: 10 puparia mixed with 8 puparia of *P. metallica* (Townsend), Cumberland Co., Allegany, mockingbird nest #3733, 7/12/00. MASSACHUSETTS: 9 puparia, Worcester Co., Worcester, eastern bluebird nest #4129, 7/16/00. MICHIGAN: 35 adults, 80 puparia, Hanover, eastern bluebird nest #4397, 8/10/00; 15 adults

Table 1. Extended.

|  | Adult Female     |                  |                   |
|--|------------------|------------------|-------------------|
|  | Midwest          | East             | Sabrosky* East    |
| <i>Frons</i> Head                      | 0.26 (0.23–0.28) | 0.25 (0.22–0.28) | 0.265 (0.24–0.29) |
| <i>Frons</i> Ocellar Span              | 2.97 (2.83–3.18) | 3.13 (2.82–3.27) | 3.31 (3.06–3.73)  |
| <i>Parafacial</i> <i>Frons</i>         | 0.56 (0.51–0.63) | 0.56 (0.5–0.61)  | 0.555 (0.52–0.62) |
| <i>Parafacial</i> Ocellar Span         | 1.67 (1.58–1.83) | 1.73 (1.5–1.91)  | 1.84 (1.65–20.0)  |
| <i>Parafacial</i> Vibrissal Interval   | 1.09 (1.05–1.25) | 1.12 (0.9–1.24)  | 1.12 (1.0–1.32)   |
| <i>Cheek</i> Eye                       | 0.46 (0.42–0.5)  | 0.45 (0.39–0.49) | 0.44 (0.42–0.46)  |
| <i>Frons</i> 3rd Antennal Segment      | 3.12 (2.91–3.36) | 3.18 (2.75–3.4)  |                   |
| <i>Parafacial</i> 3rd Antennal Segment | 1.74 (1.64–1.83) | 1.77 (1.64–1.91) |                   |

and 110 puparia, same location and host as above, nest #4399. MINNESOTA: Four eastern bluebird nests from St. Paul; 150 adults, 210 puparia, nest #3886, 7/15/00; 45 adults, 50 puparia, nest #4241, 8/7/00; 10 adults, 110 puparia, nest #4240, 8/6/00; 2 puparia, nest #4239, 8/6/00; 40 adults, 50 puparia, Sartell, eastern bluebird nest #5198, 7/21/01. NEW JERSEY: 7 adults, 6 puparia, Newtonville, house wren nest #3978, 6/30/00; 8 puparia, Medford, eastern bluebird nest #2717, 8/3/99. NEW YORK: 70 adults and 70 puparia, mixed with 5 *P. bennetti*, Cattaraugus Co., Franklinville, tree swallow nest #4073, 7/25/00; 110 puparia, same location as above, kestrel nest #4076, 7/25/00; 5 puparia, Gloversville, eastern bluebird nest #4465, 5/25/00. OHIO: 75 adults, 110 puparia, Richland Co., eastern bluebird nest #2713, 7/15/99; 19 puparia, Stark Co., Louisville, tree swallow nest #4385, 7/24/00. PENNSYLVANIA: 75 adults, 85 puparia, Harrisburg, tree swallow nest #2638, 6/28/99. RHODE ISLAND: 23 puparia, North Kingston, tree swallow nest #4896, 6/10/01. TENNESSEE: 32 puparia, Knoxville, eastern bluebird nest #5399, 8/4/01. VIRGINIA: 3 eastern bluebird nests from Roanoke Co., Roanoke: 35 adults, 40 puparia, nest #3338, 5/15/00; 50 puparia, nest #4146, 7/25/00; 160 puparia, nest #4147, 7/25/00. VERMONT: 9 adults, 55 puparia, Franklin, tree swallow nest #4350, 7/12/00. WEST VIRGINIA: 11

adults, 45 puparia, Marion Co., Fairview, eastern bluebird nest #3386, 6/10/00; 15 adults, 43 puparia, Lewisburg, tree swallow nest #3616, 6/15/00. WISCONSIN: 15 puparia, Dunn Co., Colfax, eastern bluebird nest #4942, 6/5/01; eight eastern bluebird nests, Dane Co., Black Earth: 35 adults, 39 puparia, nest #3295, 5/10/00; 3 adults, 15 puparia, nest #3296, 5/10/00; 45 adults, 50 puparia, nest #4279, 5/25/00; 15 adults, 28 puparia, nest #4282, 8/7/00; 2 adults, 25 puparia, nest #4290, 6/29/00; 45 adults, 56 puparia, nest #4302, 5/25/00; 25 adults, 35 puparia, nest #4320, 5/25/00; 30 adults, 40 puparia, nest #4326, 6/6/00.

Specimens examined.—847 adults, 1988 puparia.

Distribution.—Alaska, Connecticut, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, Virginia, Vermont, West Virginia, Wisconsin, Ontario and Saskatchewan, Canada (Fig. 1). These are the first records of this species from Indiana, Illinois, Kentucky, Minnesota, Rhode Island, Tennessee, and Wisconsin. Sabrosky et al. (1989) recorded this species from Delaware, New Brunswick, Northwest Territories, Ontario, South Dakota and Georgia.

Hosts.—Eastern bluebird, great-crested flycatcher, kestrel, purple martin, northern mockingbird, house sparrow, barn swallow,

Table 2. Mean ratios and ranges comparing western, midwestern, and eastern puparia of *Protocalliphora sialia*.

|                           | West   | Midwest  | East   | Sabrosky* East                                |
|---------------------------|--|--|--|---|
| # Puparia Measured        | 53   | 21   | 17   | 150   |
| Ventral Band Ratio        | 0.72 (0.57-0.85)<br>175 $\mu$ (143-210 $\mu$ ) | 0.79 (0.67-0.89)<br>193 $\mu$ (150-220 $\mu$ ) | 0.83 (0.71-0.89)<br>191 $\mu$ (168-215 $\mu$ ) | 0.89 (0.8-10.0)<br>190 $\mu$ (140-235 $\mu$ ) |
| Diameter Stigmatal Plates | 576 $\mu$ (460-710 $\mu$ )                     | 520 $\mu$ (420-660 $\mu$ )                     | 522 $\mu$ (430-660 $\mu$ )                     | 450 $\mu$ (235-690 $\mu$ )                    |
| Between Buttons           | 1176 $\mu$ (980-1370 $\mu$ )                   | 1115 $\mu$ (1010-1240 $\mu$ )                  | 1147 $\mu$ (1020-1380 $\mu$ )                  | 1000 $\mu$ (655-1390 $\mu$ )                  |
| Across Plates             | 0.48 (0.41-0.60)                               | 0.46 (0.41-0.56)                               | 0.46 (0.39-0.53)                               | 0.46 (0.43-0.56)                              |
| Stigmatal Ratio           |  |  |  |   |

\* Data from Sabrosky et al. 1989.

tree swallow, tufted titmouse, house wren. The mockingbird and tufted titmouse hosts are new records for *P. sialia*.

*Protocalliphora (P.) occidentalis*

**Whitworth, new species**

(Figs. 2c, d, 3b, d)

*Protocalliphora (P.) sialia*: Sabrosky et al. 1989 (in part).

Diagnosis.—*Protocalliphora occidentalis* adults are very similar to those of *P. sialia*, however male *P. occidentalis* have a narrower frons (0.08 vs. 0.10) (Table 1) and a smaller polished preocellar area (Fig. 3b vs. 3a); female *P. occidentalis* usually have a dull preocellar area (Fig. 3d) while *P. sialia* have a polished preocellar area (Fig. 3e). The stigmatal region of puparia in *P. occidentalis* usually has folds faint or absent (Fig. 2c) vs. distinct folds in *P. sialia* (Fig. 2a); ventral band ratios in *P. occidentalis* average 0.72 (0.57-0.85) vs. 0.83 (0.71-0.89) in *P. sialia* (Table 2).

Male.—Mean ratios for *P. occidentalis* compared to *P. sialia* given in Table 1. Frons usually narrower than *P. sialia*, preocellar area triangular, polished and 1-1.5 times depth of median ocellus compared to 2-2.5 times in *P. sialia*.

Female.—Mean ratios for head compared in Table 1. Preocellar area usually dull microtomentose, while in *P. sialia* usually large and polished (Figs. 3c, d).

Puparium.—Mean ratios for puparial characters compared in Table 2. Compared to *P. sialia*, *P. occidentalis* with smaller ventral band ratio, ridges in hyperstigmatal, mesostigmatal, and hypostigmatal areas faint or absent vs. moderate to prominent, mesostigmatal and hypostigmatal area spines sparse, short, and often reduced to tubercles vs. spines dense to 15 $\mu$  long.

Types.—Holotype  $\sigma$ , allotype and 42 paratypes (26  $\sigma$  16  $\text{♀}$ ) with matched puparia from Washington State, Kittitas Co., Umtanum Ridge (road), 6/15/99, mountain bluebird nest #2612. Holotype and allotype in the National Museum of Natural History,



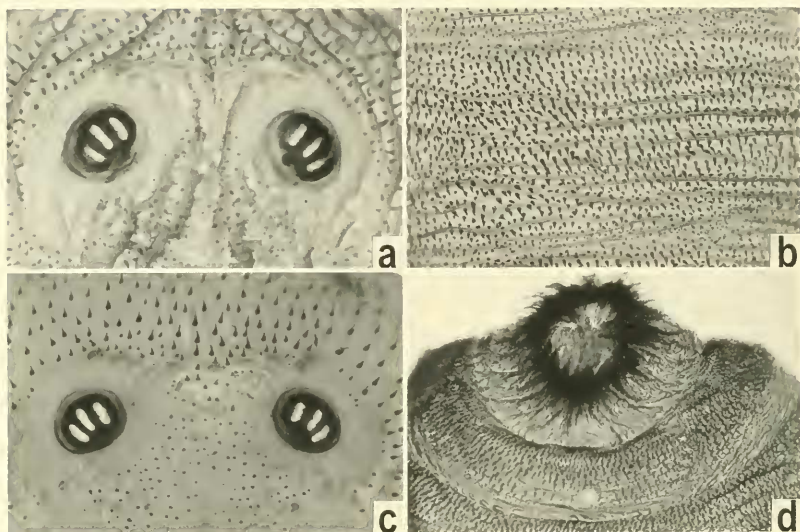


Fig. 2. Puparium of *Protocalliphora sialia*. a. Stigmatal view. b. Dorsum. Puparium of *P. occidentalis*. c. Stigmatal view. d. Prothoracic fringe.

Smithsonian Institution, Washington DC. Paratypes there and at Utah State University, Logan, Utah, and Washington State University, Pullman, Washington.

Additional paratypes.—CANADA, BRITISH COLUMBIA: 7 adults, 40 puparia, Osoyoos, western bluebird nest #3708, 7/1/00; 20 adults, 115 puparia, Osoyoos, tree swallow nest #3714, 7/1/00; 3 tree swallow nests, Dykes area 30km south of Prince George, Summer 2001, Russ Dawson collector: 7 puparia, with 9 *P. rugosa*, and 3 *P. bennetti*, nest #5793; 3 puparia with 28 *P. rugosa*, nest #5795; 10 puparia, nest #5807.

UNITED STATES: ARIZONA: Three western bluebird nests, Fredonia County, Mt. Trumbull: 10 adults, 110 puparia, nest #4015, 7/14/00; 35 adults, 115 puparia nest #4029, 6/10/00; 5 adults, 23 puparia, nest #4275, 8/7/00. CALIFORNIA: 11 puparia, El Dorado Co., Mt. Akum Road, western bluebird, nest #2815, 7/10/00; 10 puparia, Rescue, violet-green swallow nest #3690, 7/

7/00; 110 puparia, Amador Co., Somerset, western bluebird nest #3849, 5/6/00. COLORADO: 130 adults, 175 puparia, Durango, ash-throated flycatcher nest #3620, 6/25/00; 2 adults, 35 puparia, Grand Junction, ash-throated flycatcher nest #3686, 7/4/00; 30 adults, 110 puparia, Durango, ash-throated flycatcher nest #4101, 7/15/00; 49 adults, 115 puparia, Durango, ash-throated flycatcher nest #4108, 5/13/00; 85 puparia, Lyons, tree swallow nest #4142, 7/25/00. IDAHO: 2 puparia, Bonner Co., Athol, tree swallow nest #4039, 7/5/00; 36 adults and over 150 puparia, Kootenai Co., Hoodoo Valley, tree swallow nest #4267, 7/25/00. MONTANA: 48 adults, 75 puparia, Granite Co., Philipsburg, mountain bluebird nest #3497, 6/18/00; 31 adults, 65 puparia, Granite Co., Philipsburg, mountain bluebird nest #3501, 6/16/00. NEW MEXICO: 9 adults, 92 puparia, Arroyo Seco, western bluebird nest #4392, 7/15/00; 9 adults, 12

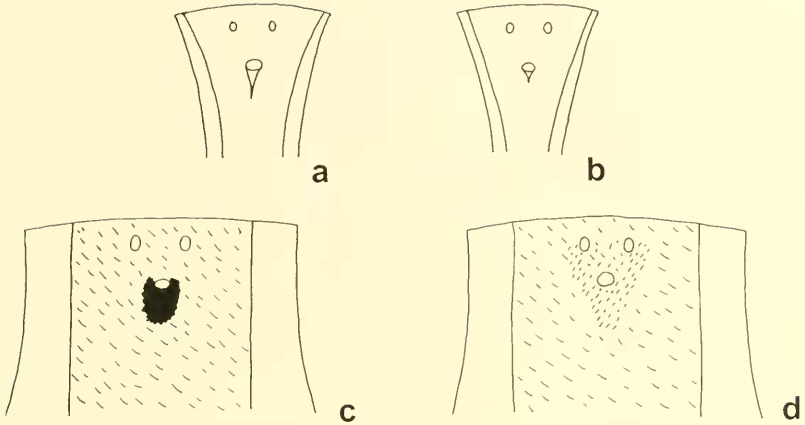


Fig. 3. Preocellar area of frons. a. Male *Protocalliphora sialia*. b. Male *Protocalliphora occidentalis*. c. Female *P. sialia*. d. Female *P. occidentalis*.

puparia, Arroyo Seco, violet-green swallow nest #4395, 7/29/00. OREGON: 3 nests from Springfield; 15 adults and 32 puparia, western bluebird nest #3739, 6/16/00; 1 adult, 9 puparia, tree swallow nest #3740, 7/2/00; 12 adults, 27 puparia, tree swallow nest #5550, 7/14/01. UTAH: 1 adult, 35 puparia, Cache Co., Franklin Basin, tree swallow nest #359, 7/18/70; 1 puparium mixed with 5 puparia of *P. hirundo*, Rich Co., Walton Canyon, cliff swallow nest #420, 7/22/70; 5 puparia mixed with 45 puparia of *P. parorum*, Box Elder Co., Mantua, house wren nest #569, 7/8/69; 15 puparia, Cache Co., Logan Canyon, house wren nest #1050, 7/5/71; 12 puparia, Cache Co., Logan, house sparrow nest #1302, 8/14/71; 2 *sialia* puparia mixed with 16 *P. rognesi* Thompson and Pont [*P. chrysorrhoea* (Meigen)] puparia, Cache Co., Wellsville, bank swallow nest #1906, 6/26/74; 22 adults, 115 puparia, Ogden, European starling nest #3764, 7/15/00. NEVADA: 6 puparia, Eureka, mountain bluebird nest #2926, 9/3/99; 2 puparia, Eureka, mountain bluebird nest #2927, 9/10/99. WASHINGTON: 34 adults with matched puparia, Kittitas Co., Umtan-

um Ridge, mountain bluebird nest #2611, 6/15/99; 20 adults with matched puparia, Kittitas Co., Umtanum Ridge, bluebird spp. (mountain or western bluebird) nest #2609, 6/15/99; 24 adults, 54 puparia, Kittitas Co., Umtanum Ridge, mountain bluebird nest #4226, 7/2/00; 22 adults, 35 puparia, Kittitas Co., Umtanum Ridge, western bluebird nest #4228, 7/10/00. Additional paratypes to the same locations as the type series, also to the Spencer Entomological Museum, University of British Columbia, University of California, Berkeley, California Academy of Science, and my personal collection.

Specimens examined.—533 adults, 1878 puparia.

Distribution.—Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, British Columbia, Canada and probably Mexico (Fig. 1). This is the first record of *P. occidentalis* from Nevada.

Hosts.—Mountain and western bluebird, mountain chickadee, ash-throated flycatcher, kestrel, pygmy nuthatch, red-breasted nuthatch, white-breasted nuthatch, house sparrow, European starling, barn swallow,



tree swallow, violet-green swallow, oak titmouse, Bewick's wren, house wren. The red-breasted nuthatch and Bewick's wren hosts are new records for *P. occidentalis*, nests were contributed by Don Dahlsten, University of California, Berkeley.

**Etymology.**—The name is taken from the Latin, *occidental* or "western" which reflects the U.S. distribution of this species.

#### DISCUSSION

**Variation.**—Individual adults of both species are difficult to distinguish from *P. bennetti*, *P. hirundo*, *P. rugosa*, and *P. shannoni*. See Whitworth (2002) for a key to these species. Lone females of *P. occidentalis* are virtually indistinguishable from female *P. rugosa*. Males of both species in good condition are usually distinctive, but dirty, teneral, or undersized specimens are a problem. The most distinctive feature of both species is the long prothoracic fringe in the puparia, which is usually 500 $\mu$  in diameter or more. Only *P. parorum* Sabrosky et al. has a fringe that comes close, with some specimens to 450 $\mu$ , and averaging 425 $\mu$ . Occasionally specimens of *P. sialia* with undersized prothoracic fringe are found. The only Alaska specimens collected were puparia from two tree swallow nests in Fairbanks, and all had a smaller than usual prothoracic fringe ranging from 400–475 $\mu$ . Based on the material available, I have concluded they are *P. sialia*, but characters are somewhat intermediate and until more material is examined, including adults, this is a tentative identification. The fringe of occasional specimens of *P. sialia* in the eastern U.S. were similarly reduced, but this was unusual. Some specimens of *P. occidentalis* from southern British Columbia, Washington, and Utah had an unusually long prothoracic fringe to 800 $\mu$ . Sabrosky et al. (1989) noted apparent normal body length for *P. sialia* (which included the eastern and western forms) was 8.5–9.5 mm. However I reared many *P. sialia* that measured up to 10 mm, while *P. occidentalis* usually were 8.5–9.0 mm (rarely to 9.5

mm). This suggests that *P. sialia* tends to be longer, but size is not a good species character because nestlings often fledge before all larvae mature, producing some undersized adults.

The puparia of both species sometimes exhibit significant spine reduction in the mesostigmatal area. This is shared only with *P. parorum* among specimens with pronounced dorsal ridges. This character is common in *P. occidentalis* but also occasionally occurs in *P. sialia*. In *P. occidentalis* the stigmatal area of puparia usually has no folds, *P. sialia* usually has pronounced to moderate folds. Scattered specimens of *P. sialia* from Ohio, Wisconsin, and Virginia also had reduced folds.

**Distribution.**—The apparent wide separation of eastern and western populations by the Great Plains (Fig. 1) may prevent interbreeding and result in speciation. Specimens reared from nests in the extreme eastern or western U.S. are usually very different, but midwestern puparia often have some intermediate characters that suggest interbreeding is occurring. Few nests have been examined from the Great Plains so the absence of specimens from that area may be due in part to the lack of collection effort. However, *P. sialia* prefers the nests of birds in cavities and the lack of trees in the Great Plains could prevent populations from crossing the plains. With the expansion of farms and towns across the Great Plains in the past 150 years, the two populations of *P. sialia* recently may have had more opportunity for contact. Manmade structures often provide nest cavities and have shade trees or rows of trees for windbreaks, which also provide nest cavities. The introduction of the European starling, over 100 years ago, could have helped the two species meet across the Great Plains since it is a favored host of both species and often nests in and around manmade structures (Bennett and Whitworth 1992). More recently, many homeowners have begun installing nest boxes in places with few or no natural cavities to encourage blue-

birds and other cavity-nesting birds, which may attract and disperse both species in areas without trees.

Some regions seemed to be totally devoid of both species, despite the fact that favored hosts like the eastern bluebird were abundant. The following nests and sites had neither species: sixty eastern bluebird nests in eastern Texas, 99 eastern bluebird nests in southeastern Oklahoma, 16 eastern bluebird nests in southeastern Nebraska, 24 eastern bluebird and purple martin nests in northern Missouri, 25 eastern bluebird nests in Arkansas, and 35 eastern bluebird and tree swallow nests in south central Iowa. *Protocalliphora sialia* or *P. occidentalis* has never been recorded from Arkansas, Missouri, Nebraska, Oklahoma, or Texas although *P. sialia* was found in northern Iowa. *Protocalliphora deceptor* was found in each of the above areas and occasionally infested nests which would usually be infested by *P. sialia*. With the absence of their usual parasite, eastern bluebird nests in these areas were rarely infested. In areas where these parasites were common, infestation rates in favored host nests often approached 100%. Neither species was found in North or South Dakota, or eastern Montana, but few nests were examined from those areas, so further study is needed before assuming they don't occur there. Sabrosky et al. (1989) recorded *P. sialia* from an unknown location in South Dakota. *Protocalliphora sialia* was never found in any of the southeastern states south of Tennessee including South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana, although Sabrosky et al. (1989) recorded it from northern Georgia. In fact, *Protocalliphora* appears to be rare in much of the south, although I have recently examined a series of 8 nests (wrens, chickadees, and warblers) from Smith County, Texas, that were all infested with *P. deceptor*; several nests had over 100 puparia. This 100% infestation rate is in sharp contrast to infestation rates of 1%–5% by *P.*

*deceptor* in over 200 nests examined from other areas of Texas.

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